FOOD IN ITS RELATIONS TO ENERGY AND HEAT.

A. RABAGLIATI.

THE FUNCTIONS OF FOOD IN THE BODY.

DOES EITHER BODILY ENERGY OR BODILY HEAT COME FROM THE FOOD?

BY

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NOT BY BREAD ALONE.

PREFACE.

The substance of the following brochure forms the third conversation or talk with women, in a series which I am proposing to hold with them regarding their health and that of their children. As, however, I do not know when I may be able to get that small book published, and as the matter of this treatise is common to men, women, and children, being fundamental to all, and indeed, as it appears to me, affecting not only human beings, but all organisation, plant and animal alike, I have thought it right to put what I have to say into the present form. I do not propose to make any practical application of the principles of my treatise. I hope the reader will see them for himself, and if he thinks that by the application of them he may be able to reduce greatly the number of diseases from which he suffers, that conclusion will be in accordance with the writer's views. I hope that the urgency and the serious import of the considerations advanced in this treatise will not fail at least to impress the reader, and in his mind justify the existence of it.

I think I ought to say here, that my mind has been set on this train of thinking by a correspondence I have

had with a thoughtful young layman in New York, Mr. Hereward Carrington. When he first suggested to me that neither the work of the body, nor the heat of the body came from the food at all, I admit that I was tempted to put the idea from me as being unworthy, even of a moment's consideration. It seemed so totally opposed to all the accepted doctrines of modern science, and in particular to the law of the conservation of energy, as that law is usually stated, that I thought it was useless to think of it any further. But as time went on, his suggestion kept presenting itself to me, and re-presenting itself to me, again and again; and very soon I saw that it was not only quite in keeping with the law of the conservation of energy, but was in fact most eminently so; and by and bye I came to think that his suggestion regarding the mechanical energy of the body was certainly sound, and that that regarding the heat might be so also. Of course the way in which I have worked the ideas out are my own, and for that I am entirely responsible; but it is only right to say that the idea in its twofold form emanated from him. In the course of my enquiry also I have come to see that the law of the conservation of energy may be stated in cruder and also in subtler forms; and for that discovery also I have to thank him,

1, St. Paul's Road,

Bradford, *February, 1907.*

THE USES AND FUNCTIONS OF FOOD IN THE HUMAN BODY.

According to opinion so generally accepted, as that it may be said to be universally so, the functions or uses which food subserves in the human body are three. These are :—

1. Food must be taken into the body in order to repair the waste which the body sustains in doing or performing work. It must also be taken, in order to provide the material out of which the growing body is formed. I admit the truth of this proposition in both its forms.

2. Food must, it is said, be taken, in order to provide the source or material from which comes the energy of life. The work done by the body, comes, it is said, from the food. There are, however, two views as to how this comes about. Some think that the work comes from the consumption of the bodily tissues themselves; while others think that food oxidation is the source of the work, without the necessity of its first being converted into body-stuff. On both these views, however, the food may

be considered as the source of the work of the body, because the body is made from the food. On the former view, the food is the somewhat remote source of the work —energy of the body; on the latter view the food is the immediate source.

3. The third accepted, or almost universally accepted view, as to the function of food, and the need of taking it into the human and animal body, is that it is said to be the source of the heat of the body. The food is believed to provide the heat by which the body of a warm-blooded human being is maintained at a temperature many degrees higher than that of the air (or water or earth) in or on which he lives.

I am sorry to say that I disagree with the belief, the common scientific belief, in the truth of both of these last two opinions. I am perfectly certain that the food is not the cause of the work of the body; either of its intellectual, moral, emotional, or volitional work on the one hand; or of the mechanical work of the body, whether internal, as in the various manifestations of functional activity, or external, as in locomotion, or the doing of what is commonly called work on the other. The food has no relation whatever to these things, other than that very indirect one, which is connected with the first admitted function of food, namely the building up of

the bodily structures, so as to fit them to be the means or medium through which energy acts. The body is in my view a medium for the reception, storage, and transmission of energy, but neither it, nor the food out of which it is made, is the source of the energy. Nextly, I think it is open to very grave question whether the oxidation of food is the cause even of the maintenance of the bodily temperature. The task of this treatise is to put the reader in possession of the evidence which has made me quite certain on the first point, and almost so as to the second.

The last scientific exponents of accepted views (Friedenwald & Rühraḥ: "Diet in Health and Disease," pp. 32 and 33) writing in May, 1906, say: "food is required for two purposes; to build up the 'body'"—they mean before full growth, during childhood—"and repair tissue-waste and to supply 'energy and heat.'" I am separating the supply of work-energy from the supply of heat for purposes of convenience; but am stating the accepted views. Modern science considers energy and heat as fundamentally one. I should prefer the statement that all kinetic (or active) energy is probably warm, to the statement that it is heat. If, however, warmth is not a quality of all kinetic energy whatever, it *is* a quality of all energy animating what are called living things. I should

like to be allowed to name Vital energy as Bio-dynamic, and to say that it manifests two forms: what we may call Bio-potential, or Bio-dynatic (in order to avoid the verbal hybridism of Bio-potential) and Bio-dynamic. In this respect it corresponds with the forms or phases of electric energy, known as electro-potential and electro-dynamic, and it is convenient to have similar terminology for naming corresponding qualities of sister powers.

The writers named, however, go further than accepted views warrant them, and further, I think, even than they mean themselves, when they say "Every act consumes energy. If a man lifts a pound a foot high, he must reproduce in his body hat amount of energy. This energy is obtained from the food." *Consumes ?* Energy. Is energy consumed? No; they do not mean this. They mean rather that potential energy in the food has been changed into kinetic energy in the body, providing the material through whose combustion heat and motion have been maintained in the body. But it is a loose expression, unjustified by modern scientific opinion, to speak of energy being consumed. If it were so, there would be less energy now than there was a thousand or a million years ago; and it would follow that in another thousand or million years there will be less energy than there is to-day. But no evidence justifies us in saying

either of these things, nor is it in consonance with modern views. The second part of their statement is also expressed with unjustifiable looseness. "He must *reproduce*," they say, "in his body that amount of energy." *Reproduce?* Does a man produce or reproduce energy in his body? What if he *receives* it? I think he receives it. He does not appear to me to produce it or reproduce it, or create it in any way. The body seems to me to produce or create nothing. What it emits it first receives—after elaboration no doubt; but still it must first receive. And then they say "this energy is obtained from the food." Well this is the point I propose to discuss; and I am sorry to be compelled to question the soundness of the view which attributes either the work of the body or even the heat of the body to the food.

As to the work of the body, this is of two great sorts; what may be called mental on the one hand; and mechanical on the other. The reader will understand that by the term 'mental,' I mean not only intellectual, but also emotional, spiritual, and volitional energy. It is in this sense of the word I take it, that our writers mean to be understood when they say (p 35), "But the relation of energy and food to mental labour is a problem that has never been worked out." Now I wish to draw the reader's special attention to this point. In what respects does the

work of the human machine differ from that of the machines or bodies of lower animals? Obviously chiefly in that of "mental labour." Yet even the dog has a certain amount of mental power; and all different animal forms show different amounts and powers of mental labour, in accordance with the varying structures, chiefly of their respective nervous systems. Suppose we were to term human mental labour "Anthropino-byo-dynatic and dynamic," and that of the dog "Canine-byo-dynatic and dynamic,' and to ask ourselves what relations these powers have to one another, and particularly what relations "Canine-byo-dynatic" and "Canine-byo-dynamic" bear to the dog's food; is there a single fact known to physiologists which would enable us to equate these two? To co-relate them? Who ever heard of any relation whatever being shown to exist between a dog's food and the mode in which he can find his way about? and return home when he wants to? There are no facts known to physiologists by which these mental, or quasi-mental characteristics can be co-related with the dog's food. And so on through the whole series of animals, birds, reptiles, fishes, and mammals. No relations have ever been shown to exist between "Hippo-byo-dynamic," or "Elephanto-byo-dynamic," and the food of horses or elephants. Many facts of course are known which go to

shew that natural mental powers of animals work better or worse according as the animal is fed more properly or less properly. No doubt if an animal body is choked up with excess of food-stuff, its powers are all deteriorated, its powers of doing mental labour among the rest. But the power of doing mental labour existed at any rate in the potential or dynatic form prior to the taking of any food. And much less has any such relationship ever been determined between the mental powers of men and the food which they ingest into their bodies. Now does not the reader think this is a very curious thing? Who ever heard of the plays of Shakespeare, or the songs of Burns, or the principia of Newton being determined by the food of these respective authors? Obviously no one ever did, and I venture to believe never will show any direct relation subsisting between these two sets of very different things. I therefore do not propose to make any further reference to the mode of production or to the source of these powers of man, and animals. But inasmuch as it is in respect of his mental characteristics in a wide sense that man's powers enormously transcend those of all other animals, so much so, indeed as to place him in a class by himself, it is to me, I must say, somewhat curious that the same scientific men, who speak so easily of energy being "produced," and of energy being

"consumed," should be obliged to add that the relation between energy and food to mental labour is a problem that has never been worked out. Does not the fact that they are compelled to do so raise the presumption in the reader's mind that probably the mode in which they view the relationship between food and mechanical energy may itself require to be reconsidered? If they have admittedly failed to show even the slightest relation between the food and the higher powers of the organism, is it not probable that the mode in which they view that relationship to the lower powers may also require reconsideration?

It may tend somewhat to clarify our ideas if we consider for a little, some aspects of this question. It really is a question of materialism or idealism, which forces itself on our mind. Theologically there may be three classes of religionists; the materialists, the immaterialists or idealists, and the agnostics. Even philosophically these three classes may exist or temporarily co-exist; but scientifically, that is to say, viewing man in relation to the facts of life, the agnostic can scarcely find a place for the sole of his foot. We all believe in the existence of one another though we never meet; and therefore we need only consider the materialists and the idealists. Modern science is so wholly materialistic that

idealism can scarcely be mentioned without arousing signs of discord and even scorn and contempt. So certain is modern science that thinking is a function of the brain, that the man who hints that the brain, its conformation, its structure, its position, are functions of thinking, has difficulty in finding a hearing. Material monism is so much in evidence that immaterial or idealistic monism is laughed out of court. And yet her position appears to me to have quite as much warrant as the other; indeed I think much more. It is, of course very difficult, if not impossible to argue an opponent out of his position. The answer we give in the end almost appears to depend upon feeling rather than upon reason; but the idealistic position which I take up, and which I am compelled to take up, appears to me to be a feeling, if such it is, founded on eminently rational reason, and in accord with a process of ratiocination, which is concordant with the totality of things as we know them. When structure and function are co-ordinated and co-related, and proportionate one to the other, the one varying as the other varies, and the other as the one, co-ordinately and proportionately and simultaneously, it is not in the nature of things easy to say which is first. Either however the thing was before the thought, as modern science almost universally asserts, or the thought was before the thing, which is the belief

of a contemptible minority, among whom nevertheless, I most emphatically range myself.

About the special phase of the question as it affects the action of the brain and the function of thought; a most remarkable oversight appears to have been committed. Unlike all other organs of the body, the circulation of the blood, when it reaches the brain ceases to be under the government of the heart and its mechanism, and comes under the government either of the respiration, or that portion of the nervous system which governs respiration. That is to say that, whereas circulation in the stomach and liver, and pancreas, and spleen, and kidneys, and even in the membranes of the brain, moves at the rate of 60, 70, 80, or 90 times a minute; that of the brain moves only at the rate of from 15 to 18 times a minute. The muscles are the organs of mechanical work; the brain is the organ of mental work. It has been known for 150 years that the circulation in the brain moves with the respiration, while that in the muscles moves with the blood circulation. How is it that this fact has never been made use of by physiologists? Their refusal to use it, or their blindness as to its meaning is almost certainly a great part of the reason why the writers above mentioned have been compelled to make the poverty-stricken admission already quoted. How is it possible that the functional

actions of the brain could be equated with the nutrition of the organ, when an essential part of its mechanism although known for a very long time, has been persistently overlooked? The first point which I have to make then, in the attempt to co-ordinate the work of the body with its food and nutrition, is to emphasise the fact that according to the admission of the latest authorities; and also in accordance with the facts of the case, no relation between mental labour and the food has ever been worked out. And as this is so, and as the ordinary doctrine entirely fails to explain the relationship between the food and the higher functions of the human machine, it seems to me that a presumption is raised against the adequacy of the ordinary doctrine, to explain the relationship between nutrition and the manifestation of mechanical energy either. I now therefore proceed to examine the prevailing opinions of science as to the relations between the food taken into the body, and the manifestations of mechanical energy.

1. Let me, however, say a word or two respecting the power of food to repair the waste of the body, and to provide the material out of which the increase of the body, in infancy, childhood, and adolescence comes. This double function I admit, and I believe this is the only use subserved by food in the body, to repair waste, not to

supply the material out of which work (or even heat?) comes, but only to repair the waste the machine sustains in doing or being the vehicle of the doing of the work. It does not seem to me even that the body does the work; it is the vehicle of the work, or the instrument through which the work is done, as the strings of a harp or violin are the means through which the tune is played. When work is done by means of any machine, the matter of which the machine is made, wastes in the performance of it. The parts of a steam engine waste through the friction of going, through what may be called the internal work of the machine, irrespective, that is, of whether the engine is performing useful mechanical work or not. If in addition to mere going, the engine is performing mechanical work, driving machinery for weaving, spinning, or propelling a ship through the water, etc., the engine wastes more. The motor at the bottom of the electric tram-car wastes in the act of going, and the more miles it runs the tram-car, as also the steeper the inclines it has to mount, the more it wastes. Similarly the animal body or the material of which it is made, wastes in the mere act of doing the internal work of life, of carrying on the internal work of breathing, digesting, the movements of circulation, peristalsis, and so on. If in addition to these internal motions, the body performs external move-

ments of locomotion or the doing of mechanical work, the body wastes more than when it is doing only internal work. This is so. But if we ask the question, how *much* more does the body waste when performing outside mechanical work than when it is performing only the internal work of living, it is not easy to give an answer to this question. I think the answer is: the body wastes more in doing external work than when doing internal work only, but not so much more as we might be disposed to think. The strings of a violin waste, no doubt, when tunes are being played upon them, but you can get an enormous number of tunes played on the strings before they show much evidence of wear and tear; and further, a high quality of the music does not involve any more wear and tear than a low quality; generally indeed not so much. The amateur's efforts waste the strings more than do those of the expert musician, but the direct effect of the playing of the music in causing wasting of the strings is very difficult to estimate. In the body, the ultimate products of oxidation are urea, uric acid, carbonic acid, water, etc.; and it has been alleged that the quantities of these products eliminated by the body are in direct proportion to the quantities of internal and external work done; but unfortunately this is not true. It cannot be said that

they bear no proportion to the work, internal and external, done by the body, but it certainly is the case that the elimination of carbonic acid, urea and uric acid from the body bears a far more direct and noticeable proportion to the quantities of food ingested into the body than it does to the quantity of work, internal and external, performed by it. The more food is taken into the body the higher is the elimination of carbonic acid, urea and uric acid from it. Roughly speaking, carbonic-acid-elimination is the measure of the amount of carbo-hydrate and fatty-food ingested (starch, sugar, and fat) while the urea and uric acid eliminated are in proportion to the quantity of proteid food ingested (meat, eggs, fish, cheese, etc.) No doubt under excessive exertion continued for a long time, an excess of urea and uric acid has sometimes been known to be eliminated, but in these cases the feverish state has set in, when these products have been the measure, not of the work done by the body but of the material lost by it owing to the supervention of the feverish state. The problem is no longer one of the natural and healthy relations between the ingestion of food and the work done by the body; but it is one of unnatural and unhealthy conditions arising in disease. No doubt the body of a navvy, or that of a ploughman or other man doing hard work, wastes or loses more substance than does that of a

clerk at his desk; but the difference is not so much as is generally supposed.

The favourite analogy of science between the work of the human machine and mechanical power has been to compare the animal body with the steam engine. I suggest that the animal body is in its action much more analogous to the electric motor than it is to the cruder steam engine and boiler. In the latter case the main source of energy is said to be oxidation, and principally of carbon. But even as regards the elimination of heat by the consumption of coal in the furnace below the boiler, which heat converts the water into steam, whose expansion and contraction are used to move the machinery which does the work, too crude ideas seem to prevail. We say that the oxidation of the carbon is the cause of the heat, but this is not a very correct expression. It would be much better to say that the combination of Oxygen and Carbon to form Carbonic acid gas in the fire is the immediate precursor or the constant concomitant of the elimination of heat. The heat itself, however, I presume (and I think, this is the form in which modern science, when she attempts to speak accurately prefers to put her statement) was stored up in the Sun long ago, and is now liberated by Chemical action, or by the action of chemical energy between Carbon and Oxygen. If we

use the term "cause" in its scientific sense of constant sequence or constant concomitance or necessary precedence, then the Sun is the cause of the heat, while the chemical action between Carbon and Oxygen is the occasion of the liberation of the heat, The analogy of the electric motor to the working of the human machine appears to me to be a much truer one than that of the steam engine, although, as I have shown, the action of the latter is not so crude as is generally supposed. The machine at the bottom of the electric tram car, which works the car, is worked by electric energy; as we can easily see if we ask ourselves how long it would continue to work if the trolley were off the wire. For the moment however we are occupied with the consideration only of the fact, that the more work the motor does, or more accurately, the more work the motor is made the means or vehicle of doing, the more does the motor waste. The engineer keeps oiling the machine, and by and bye, when it is worn out, pulls it out and puts in a new one. But the body is self-repairing; and this is the chief difference it seems to me between the artificial machine made by man, and a natural machine made by Nature, pro-created, as it appears to be by dynamism or energy; which energy is created by or emanates from the Author of Nature. The food, however,

is the immediate source from which the waste of the grown body is repaired, the waste which is incurred when the natural machine does internal and external mechanical work, and so far as I can see this is the sole function subserved by food in the body.

1a. The amount of waste sustained by the body in doing internal and external work.

Of course, as has been said, this waste is less or more according as the body is doing less or more work. A very great deal of labour has been expended in experiments in the attempt to determine the amount of waste sustained by the body of a man when engaged in the mere act of living, as compared with the body of the same man when doing a regulated amount of mechanical work; such for example as riding a bicycle. The apparatus employed is known as a calorimeter (heat-measurer or calorie-measurer). A calorie is the amount of heat required to raise one kilogram of water through one degree Centigrade in temperature. The results are not very conclusive. I say this because of the occurence in text books of statements like the following. I quote from Professor W. G. Thompson, of Cornell University, New York. In his "Practical Dietetics" he says:—

"Metabolism within the body is not alone controlled
"by muscular work, but by the nervous energy

"expended in its performance. For example, a day
"labourer, like an iron-founder, may be stronger,
"and do much more mechanical work, than an
"oarsman, or football player in time of contest, yet
"he expends very little nervous energy in his routine
"daily work, and requires less proteid in his diet
"than the athlete. In other words, severe muscular
"work, performed for a brief time, under conditions
"of great mental excitement and nervous tension,
"demands an excess of protein" (i.e. Food containing Nitrogen) "whereas continued muscular effort
"without great fatigue or mental strain is maintained
"upon a liberal allowance of food, which may be
"varied in composition, if it be easily digestible."

It will be observed how vague these expressions are. What is nervous energy? How is it related to food? Prof. Thompson's statements are made without any proof being offered as to their correctness. I humbly doubt if they are correct. As we shall see, the nervous system, which I imagine to be the organ through which nervous energy acts, or what we may perhaps call bio-neuro-dynamic, although I do not suggest that the nervous system is the source of that energy—this nervous system is most stable in its constitution; and we shall see later that even under severe and prolonged fasting it

scarcely wastes at all. The statement therefore that when severe muscular work is performed under conditions of great mental excitement and nervous tension, excess of protein is demanded, rests, I venture to suggest, on no basis of proof at all. None at least is offered.

Another quotation from the same author may be made, to account for my saying that this whole subject is in a very unsatisfactory condition.

> "It still remains extremely difficult" he says, "in "the case of all foods to trace their finer uses in the "body, and determine with any approach to "accuracy, what proportions of each furnish re- "spectively, energy, repair of tissue, and heat, for "there are no more complex chemical processes "known, than those of tissue-metabolism." I do

not know that I could have put my own view or my reasons for holding it into better expression than this. Since it is so extremely difficult to determine these things, one is left to wonder still more, on what grounds the previous statement regarding the need for an excess of protein, when severe muscular work is performed under great nervous tension, was made.

EFFECTS OF FASTING.

A form of experiment which it has fallen to me to have made in the course of my professional life, appears

to me to introduce, if not a better method of inquiry, at least another and corroborative one, into the question how much the body of a man wastes in the mere act of living. In order to cure a man of constant sickness, which had lasted for seven years, I advised him to fast for a period of 35 days. During this time he took only the whey from a pint and a half of milk a day. He did not take the curd. During the period of 35 days the man lost 13½ pounds avoirdupois in weight. The average loss during the 35 days was about six ounces a day. Or if he had two ounces of food as the quantity he took (but he did not take the equivalent of two ounces of solid food of any kind) then we may consider that he lost eight ounces of weight a day during the period, and that therefore he would require to take for doing the light work of walking about, and performing little domestic duties, as much food as would suffice to replace this amount of loss. I think the general feeling of readers of this statement will be that the loss is much less than they supposed. Nevertheless it corresponds with other observations of mine, notably one, in which a lady suffering from chronic rheumatism, maintained her weight for a considerable period of time on an allowance of eight ounces of food daily. In another case in which the food was frequently weighed, and

amounted to seven or eight ounces daily, a lady actually increased her weight by about four pounds avoirdupois in three years. While, therefore, I do not call into question the universal belief that food must be taken into the body in order to repair the waste it sustains in the doing of work, I add that this waste is much less than is commonly supposed. How seriously this estimate differs from authoritative statements as to the amount of food required by the average man or woman, will be evident when it is remembered that the late Dr. King Chambers recommended the nursing mother to take a weight of three pounds avoirdupois of food daily, and that some authorities speak calmly of as much as 76 ounces or nearly five pounds weight of food being consumed. In the writer's view, such amounts of food choke the bodily machine up and prevent its proper and efficient action, much in the same way as a fire may be put out by heaping up too much coal on it.

We come now to consider the two other alleged uses of food, as to both of which I am disposed to question the soundness of the universal, or all but universal belief. These are:—

(2). That the food is the source of the work of the body ; and

(3). That it is the source of the heat of the body.

2. No doubt the more work the body does ; the more digging, walking, running, hauling, etc., the man does, the more his body wastes. So do the strings of a violin, and so does the motor at the bottom of the electric tram-car, in proportion to the number of tunes played, and to the miles run. And yet it is the hand of the player which is the efficient cause of the violin-music and not the strings, although no doubt the tune cannot be played without the strings. And even the hand of the bowman is actuated by his will, so that the really efficient cause of the music is the will or mind of the player, while the strings and the wood are only the material cause, as the old writers used to express it. And to see how small a part the motor takes in doing the efficient work of the electric tram-car, we have only to ask ourselves how long could the motor work the car if the trolley were off the conducting wire ; or how long it would take to start the car, if, the trolly being on the wire, there were no current passing ? Obviously the motor is the material cause indeed of the movement of the car, and the more miles the car runs, the more does the motor waste and require repair ; but the efficient power of the work is the electric energy, which is conveyed along the wire to the trolly and the motor. Now as the electric tram-car is run by electric energy, or electro-dynatic, becoming

electro-dynamic, the body, I conceive, is run by Vital energy, or byo-dynatic becoming byo-dynamic. Like the motor, the more work the body does, or rather, let us say, the more work is done through or by means of the body, the more does the body waste, and the more food therefore must it have to replace this waste; but the body is only (like the violin or the motor) the material cause of the work done by it or through it, while the efficient cause is vital energy, or bio-dynamic, or life. The body is only the means or the vehicle of work, but the efficient cause is bio-dynamic, or vital energy, or life. I shall be asked, no doubt, what is the source of bio-dynamic? We know, it will be said, the source of the electric energy, for we know how it is produced at the nearest generating station, by steam power, or water power, or in some other way; but we have no such knowledge as to what I am terming vital energy, or byo-dynamic. What is the source of that? Well! if I cannot answer that question, I am no more to be criticized than any one else; for the man has yet to arise who can explain the origin or source of life, or vital energy, or bio-dynamic, or even of Power in general. But I may, perhaps, be permitted to suggest, that while in my view the ultimate source of vital energy is no other than the ultimate source of all other forms of energy, the

IMMEDIATE source may be the unlimited stores of energy in which we live, move, and have our being. And I think we draw on those stores according to our needs, not from the dining-room, but from or through sleep. It is during sleep, it seems to me, that our bodies charge or are charged with the vital energy or bio-dynamic, which seems to me to be the immediate efficient cause of the work done through the body.

The critic, however, is supposed to have said that we know the source of the electric energy which works the motor which works the tram-car. Do we? Does not the same question arise here, as arose when we were considering the cause of the heat of the furnace in the cruder steam engine? The electro-dynatic becoming electro-dynamic, is produced, says the critic, at the nearest generating station, by steam power or water power. Is it? Is it produced? Or is it liberated only, like the heat, which, although we thought it was produced by the coal, we found was not produced by it, but came long ago from the Sun, and was only liberated by chemical energy between Carbon and Oxygen. What if electric energy comes from the Sun also, or from the Earth? And if it does, where or whence did the Sun or the Earth get it? Do we not see that we are only pushing our difficulties a little back, and not really

answering our question at all? Is it not well for us to attempt to realise how much or how little we really know or do not know about the constitution and course of nature?

It seems then to me, in considering whether the food supplies the material, whose changes form the work of the body, that the evidence is against this view.

First, the oxidation products Urea, Uric Acid, Carbonic Acid, and Water, are proportional far rather to the quantities of the food ingested, than to the quantity of work done.

Second, while the waste of the body is proportionately greater, when the body is working, than when it is resting (in the conventional sense, of course—the living body never does rest; it does more work or less work; if it did none it would be dead) still this fact is quite compatible with the view I advocate, viz. :—That the waste incurred is due to the extra friction and wear and tear of the machine, which is acting as the vehicle of the work, or the means by which the work is being accomplished (as harp strings are the means, though not the cause of the music) although it does not supply the material out of which the work comes. Again, the ordinary view which I am opposing, has been held and advocated in

ignorance of the facts of fasting, and by persons who have taught that the body would die in about 21 days, if a person is deprived of food, but allowed to take water ; whereas, in point of fact, many persons have fasted for six weeks and longer, not only without dying, but in many instances, have experienced a positive increase of strength from the fast. It is difficult to conceive that the energy stored in the body from the consumption of food, should suffice to supply the power of work for so long a time ; whereas if vital energy, or bio-dynatic becoming bio-dynamic, is the source of the power, and if it comes into the body, as I suggest, during sleep, the whole position is easily intelligible.

There is however another line of argument to be considered, and it is connected with the facts of fasting. The man I referred to, who fasted for 35 days, lost in weight, at most, what amounted to eight ounces a day, and may have lost only six ounces ; but I put it at eight ounces in order to strengthen the argument in favour of my critics and against myself. According to accepted doctrine, even the starving man emits a calorie value of 2,000 calories a day in the form of heat loss. Now half-a-pound of best rump steak, provides energy, if perfectly oxidised, up to 547 calories. It is not to be assumed (is it ?) that a man's general tissues will have a greater calorie

value than an equal weight of bovine tissue. But in consuming this amount of tissue, whence came the other three-quarters of the calories required? We have accounted for only 547 out of the 2,000 required. If we imagine that the man could have found the other 1,500 calories for a day or two, from the stores inside of him, is it likely that he could draw on himself, at this rate for 35 days? The thing is incredible. If, however, he charged with energy of byo-dynatic, during the night, to be converted into byo-dynamic during the day, we have an easy means of accounting for the fact of his survival, and also for the other fact that he felt much stronger at the end of his fast than he did at the beginning of it. Besides this, in many cases, persons have fasted for a very much longer period than five weeks, in some cases, for even as long as 16 weeks. Whence came the energy which enabled them to do this? I shall have something more to say on this subject when dealing with the question of heat production in the body. In the meantime, however, let me say that we wake in the morning after refreshing sleep, especially if it has not been disturbed by the labour of digesting a meal taken late on the previous day, like a spring compressed, tightened and braced up by the energy, or byo-dynatic accumulated in the machine during the night, and that the spring, as it were, uncoils

during the day, liberating byo-dynamic, which may be converted into the work of the day. In the evening, the machine is therefore uncoiled, slack, dilated, tired, and ready for sleep, which again braces, tightens, and compresses it, charging it with power to go through the work of another day, or days. It is a very much more beautiful, more subtle, more delicate, more wonderful machine than we imagined. It is a machine for the reception, for the containing or holding or storing, and for the transmission of energy ; and it appears to me to be a gross libel on it to assume, as modern materialistic science does, that it transforms this energy, either out of its own tissues, or out of its food. When its substance is used as the medium of the reception and transmission of energy, the substance wastes a little no doubt, as all material things do, when they act as the medium of Power ; and food is required to repair this waste; but how little the waste is, the reader now sees. Well might the late Dr. E. H. Dewey put in his book on " The True Science of Living," that while the fat of the body wastes in starvation to as much as 91%, over nine-tenths of it disappearing in the process, while the Spleen wastes 63% and the Liver 56% in starvation, the Muscles 30% and even the Blood 17%, the Nerve centres waste not at all. These nerve centres, including the brain, are the organ of thinking, of feeling, of willing, and

of spiritual apprehension ; and in starvation they do not waste at all. As this statement is quoted from the work of a distinguished physiologist and eminent practitioner of the medical art, Dr. Dewey cannot be accused of drawing on imagination for his facts.

This beautiful and delicately constructed machine receives from its temporary tenants, or occupiers, or users, the coarsest treatment, for which it was never intended, and which it is quite unfitted to bear. And when it breaks down, and, proving itself an unfit house for the habitation of bio-dynamic, is deserted by that bio-dynamic, man is apt to blame Nature and to speak of cruelty or at least of hardship. But if a machine delicately constructed is subjected to coarse usage, what can we expect but that it should break down ? If we scour its tender mucous surfaces out by drastic purgatives when our wrong habits have blocked and plugged it up, or if in order to obviate an opposite condition we bind it up by the action of strong and contracting astringents, how can we be surprised if it shews signs of suffering under these coarse methods of handling it ? If we treat it by deadening hypnotics because it does not fall asleep, so as to charge again with bio-dynatic and bio-dynamic, instead of asking what is the cause or what are the causes of the sleeplessness, is it wonderful that the finely constructed

machine goes wrong or even breaks down altogether ? I hope that the reader will see the force of this argument, although, to be sure, the reasoning is almost as powerful even if the ordinary views are held as to the relations between food and energy, as if the reader adopts the more delicate and subtler views which I am placing before him. But I promised not to make at present the practical applications of the principles I am dealing with.

3. I now come to consider the question whether the food is the source even of the heat of the body. My opinion is that it is not. I do not know that the evidence which I am able to offer on this point is as strong as that which has led me to the positive opinion, that the food is in no sense the source of the working energy of the body, either mental or mechanical. I can imagine indeed that a reader might be convinced as to the first point, and yet fail to be convinced on the second ; but I wish to put him in possession of the considerations which have on the whole led me to this opinion. No doubt when food enters the body, and when through the process of digestion, it becomes assimilated in and into the body, heat is liberated. It is quite possible, of course, that this heat is used in maintaining the bodily heat, with which every infant comes into the world. But it is also possible—and this is my view—that bio-dynamic itself possesses heat as one of

its qualities, and that normal human bio-dynamic, or what I have called anthropino-bio-dynamic, that is the special form of bio-dynamic which animates the human machine, has a pretty constant temperature of 98.4 degrees F. It is therefore possible that the heat which is liberated in the processes of digestion is not required to maintain the human temperature, but passes into the body, and out of it again without modifying its temperature, and even without contributing to maintain the heat of life. If it does the former we fever, and this is to be avoided. In fact I have no doubt that we eat our fevers, that is, that fevers are caused by taking into the body more food, and of a more heating character than is required for the repair of its waste. But if only a sufficiency of food is taken into the body, and that of a proper quality ; so subtly, so delicately, and in so refined and recondite a way, are the assimilation processes effected that very little heat, if any, is liberated. We can see this very markedly in the action of respiration. Expired air is loaded with carbonic acid gas, as is well known ; and as the generation of carbonic acid gas, is nearly always in Nature accompanied by the liberation of heat, it was for a long time supposed that the lungs, or the blood in the pulmonary veins, which come from the lungs, would show a temperature higher than that of the rest of the blood in

the body. The lungs, where the carbonic acid gas was generated, were supposed to be the seat of the fire of the body, or the place where the heat was generated. Physiologists, however, have shown that this is not so, and that the formation of carbonic acid gas there, consists simply in the elimination of the carbonic acid gas in the venous blood, and its replacement by the oxygen of the inspired air, and that in health there is no increase of heat at all. If there is any increase of heat, the person has fallen into an unhealthy condition—disease has set in. I think the chief cause of this is taking too much food, or food, of a too heating character. As to the cause of fevers, I have no doubt, that while bad air is a contributory cause, the chief cause is an excess of food. This view I set out and defended before the Sanitary Congress, which met in Bradford in 1903. I do not then see any evidence for the view that the heat liberated (if indeed any heat *is* liberated, when food of a normal amount and kind undergoes natural digestion) increases the bodily heat above 98.4 degrees or so. In fact we do not desire that the heat of the body should rise above this point. When exposed, as in this country it almost always is, to a temperature much below its own, the body no doubt cools, and cools rapidly ; but it seems to me that as rapidly as it cools, bio-dynatic is

converted into bio-dynamic, and maintains the temperature. In winter time to prevent ourselves from feeling the cold below a point which is comfortable, we put on heat-retaining clothing, non-conducting clothing as the expression is, light fires, shelter ourselves in houses, and eat food. We do the last, as I think, under a false theory, viz. : that the heat of the body comes from the food ; and under the same delusion we eat more food in winter and of a more heating character than we do in warmer weather. It is quite possible, however, that this is a mistake. I think it is a mistake, although unfortunately I have myself in former times fallen into what now seems to me to be an error. Hippocrates expressed the very interesting opinion that a man should eat once a day only, " if it were summer time." I thought from this that he meant that a man ought to eat oftener in winter time in order to maintain his temperature. But it is possible that he only meant that in the extreme heat of the Ionian summer, a man's powers of digestion, like all his other powers, were so overtaxed, that he was unable to find energy to expend on digestion, and that in the coolness of winter, he might not be so overtaxed, and therefore might be able to digest more. In our winter, however, with its darkness, and gloom, and fog, especially when we increase the fog by the black smokiness of our manufacturing

towns, it seems to me, that our powers are so reduced, that it is very unwise to tax them with any severe digestive labour, and still more unwise, if we even add to that labour, by increasing the quantity of food we take.* And a very curious fact which seems to have a marked bearing on this consideration is, that epidemics of contagious and infectious diseases, are apt to occur in Spring. The children get their fevers then, their scarlet fever, diphtheria, and so on. The great epidemic of influenza of 1891 was at its height in March and April. May not this fact, as well as the frequent occurences of inflammatory diseases in Spring, be due to our wrong food habits in Winter, these habits, leading to the retention of quantities of unused material in the body, which unused material is thrown out of the body, when its powers are increased by the returning warmth and light of the Sun, and the general re-vivifying influences of Spring. Disease is nearly always, if not quite always, the process by which waste, effete material is being thrown out of the body ; and these inflammations and fevers of Spring are no exception to the rule.

One or two other curious facts go in my mind towards strengthening the view that food does not maintain the bodily temperature. I have known for instance the bodily

* Miss Alice Braithwaite has drawn attention to this point in her "Problems in Diet."

temperature elevated by as much as 3 degrees F. from 96 to 99 degrees, and to remain up for an hour or two, by taking a cup of simple hot coffee. It is, of course, physically impossible that half-a-pint of coffee at 110 degrees F. could have raised 120 lbs. of the bodily tissues of a man through two or three degrees, and have maintained it at that level for some hours. As a question of thermal physics this is impossible. How then did the coffee act? It did not contain any nutrient material in the conventional sense. It is inconceivable that the nutrient material contained in the coffee, if there was any (there was neither sugar nor cream in it), could have directly, by its oxidation, raised the bodily temperature. What it did do, I suppose, was to stimulate the body to use up some of the materials already accumulated in it in excess, and by freeing the body of them, to allow bio-dynamic or vital energy freer play to raise the temperature. I infer that nutritive material existed in the body in excess at the commencement of the experiment, because the temperature was sub-normal by two degrees or more, the bodily functions being choked or depressed by this cause. I have known a glass of hot water have the same effect in raising the bodily temperature, though not by 2 or 3 degrees. On the occasion to which I refer the temperature rose from 96·8 to 97·9 degrees, or through

a degree and a tenth, on taking a glass of hot water. While the experiments do not prove the negative—always so difficult to prove—that food is not by its oxidation a cause of elevating bodily temperature, they do show that it is not *ths* cause or *the only* cause, because from them we see the temperature rising without taking food at all. So far as they go, therefore, they seem to render less likely the prevailing scientific assumption that the food is the cause of the maintenance of bodily heat.

But another fact greatly corroborates this conclusion, and I do not know whether the reader may not even feel that it settles the question as against the prevailing view. It certainly goes a long way in my mind towards doing so. On the occasion formerly referred to, when I felt compelled to ask a man to fast, in order that he might be cured of grievous illness, lasting for seven years, one of the signs of the illness was a sub-normal temperature of 95 or 96 degrees F. This was repeatedly verified. On the 28th day of the fast, the temperature rose to natural 98·4 degrees F. and remained there. Here the temperature was elevated, not by taking food, whose oxidation according to accepted views, is the cause of the maintenance of the body-heat, but by abstaining from food for four weeks! How can we maintain after this that the taking of food is the cause of the maintenance of the

body-heat? What is my explanation? My explanation is this. The poor man's body was choked so by unassimilated material that he was in danger of death, and vital energy could not continue to inhabit that machine if the conditions continued or remained unfavorable. To shew that this view is correct, I may say that the elevation of temperature to natural was coincident with a large elimination of urates by the kidneys. Nothing is so instructive as observing the processes of Nature; and my eyes were widely opened by observing these two facts, of the large deposit of thick yellow urates, and of the elevation of the temperature, after 28 days fasting. I had no idea before, that unused stuff from the digestion of food, or rather from its indigestion, could remain in the body for so long a time—for that must have been the source or cause of the urates—nor that fasting might raise a sub-normal temperature. But how are these facts to be explained on the ordinary view? If food-oxidation is the cause of maintenance of bodily-heat, the food acting must have been taken over a month previously. But as if to shew that this could not be the cause, the body throws out of itself a large quantity of urates! These could not have come from the bodily tissues I think, or there would have been fever. I mean I don't think they had been built into the tissues of the body, but had been, I

imagine, somewhat loosely held in the interstices of the connective tissues. We have an analogous distinction in view when we separate in our minds between mechanical mixing of oil and water, which soon separate again, and chemical union say of O and C, when CO_2, a new body is formed. The urates it seems to me were lying mixed in the connective tissues of the body, not organically built into it. But vital energy or bio-dynamic, is the power which works in the body and which maintains (I think) its temperature. And so long as the bodily-interstices were choked with the accumulation of unused stuff from former food supplies, the vital energy had no free play, and so the man's temperature remained too low because the vital energy could not raise it up. The clogged machine would not work, the instrument would not play the tune. But when the machine became unclogged on the departure of the urates, vital energy had freer play and was able to warm the body properly, and the temperature rose to natural; the natural harmony of the instrument expressing itself in a general feeling of well-being and health.

If, as I suggest, life or vital energy or bio-dynamic is the immediate source both of the work of the body and of the heat of the body we can understand that the body is warmed by the passage of vital energy through

it and by its remaining in it. And in this connection I am greatly impressed by the fact that a copper wire conveying an Electric current is warmer than a similar and similarly situated wire not conveying such a current. The passage of the electric current warms the wire. May not the passage of the life-current, of the current of vital energy, of bio-potential converted into bio-kinetic, warm and quicken the body in a similar way? Are not electric energy and vital energy sister powers dependent in the last resort on the one and only source of all energy? And as in the case of all powers, do we not infer their existence from their effects rather than perceive them directly?

This universe of which we know so little, but whose constantly suggested questions attract our attention and stimulate our curiosity so much, appears to me to be a universe, not so much of things as of powers. The powers appear to make or pro-create the things through which they may express or declare themselves, otherwise we should not know of their existence. The only way in which we can get an answer to the question what a power is, is by asking and attempting to answer the previous (or simultaneous) question: what does it do? As trees are known by their fruits, so powers are known by their effects. This is as true of bio-dynamic and of

anthropino-bio-dynamic as of electro-dynamic or of gravitation. These powers of the universe form an orderly and graduated series, ascending as a hierarchy, and they embody themselves in a corresponding hierarchy of material forms; otherwise, so dense are our apprehensions, we should not recognise them at all. And a fact characteristic apparently of them all is that higher powers, while introducing into practical action their own peculiarities or properties, imply the continuance of all the lower powers. If there were a series of powers made in our minds, for example, of gravitation, crystallisation, chemical energy, and heat, light, and electric energy, and bio-dynamic with all its multi-form and varied forms of proto-bio-dynamic, kentro-neuro-bio-dynamic, up to synoidal-bio-dynamic, and so on through the almost infinite series of implied powers, and phases of powers, then I think it would be found that each of these powers in its own place would add its quota to the apparent (not of course to the real) sum of things, and would be found to imply the continuance and the pre-supposition of the continuance of all the lower ones. Crystallisation for instance, though higher than gravitation, implies the continuance of gravitation, since crystallising particles gravitate. Chemical energy implies differentiation as crystallisation does, but as gravitation does not, or

scarcely does. Light and heat do not act irrespective of the continuance of the powers of gravitation, crystallisation, and chemical energy. Electric energy again founds on and pre-supposes the continuance of gravitation, crystallisation, light and heat-energy (photo-dynamic and thermo-dynamic). And bio-dynamic, embodying itself in the sex contrast which corresponds with the electric positive and negative poles, implies the continuance of all of the lower powers, acting each in its own order and in its own sphere. I do not know if this adumbration of a snggestion as to the harmonious and orderly succession of the powers of the universe, accords with the truth of things, but of this I am certain, whether this is the real order or not, there is a real natural order, and synoidal-anthropino-bio-dynamic is the highest power in this embodied order of things which my very limited faculties are able to conceive. And I must add that it is to me a very inspiring thought that the wonderfully constructed machine which has been pro-created by anthropino-bio-dynamic, and with whose management for a short space of time each of us has been intrusted, should bear in its own structure, embryological and phylogenetical, marks of the course and development of its history through an eternity of generations from the beginning. Unforutnately, it seems

to me, we appear to shorten still further the interesting time during which we might continue to manage the machine, by grossly mismanaging it and choking it up through the acceptance of degrading and materialistic views as to the method of its working. That we may understand a little better the delicacy, the subtlety, the intricacy, the adaptability, and in a word the spirituality of the working of this machine, and of the many-phased power which inhabits and permeates and works through it, is the object which has compelled me to write this brochure.

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